UNIVERSITY OF MARYLAND

OFFICE OF THE PRESIDENT

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September 23, 2021

James D. Fielder, Jr.
Secretary of Higher Education
Maryland Higher Education Commission
6 N. Liberty Street
Baltimore, MD 21201

Dear Secretary Fielder:

I am writing to request approval for a new Post-Baccalaureate Certificate program in Remote Sensing. The proposal for the new program is attached. I am also submitting this proposal to the University System of Maryland for approval.

The proposal was endorsed by the appropriate faculty and administrative committees. I also endorse this proposal and am pleased to submit it for your approval.

Sincerely,

Darryll J. Pines
Glenn L. Martin Professor of Aerospace Engineering
President

DJP/mdc

cc: Antoinette Coleman, Associate Vice Chancellor for Academic Affairs
        Jennifer King Rice, Senior Vice President and Provost
        Gregory Ball, Dean, College of Behavioral and Social Sciences

Cover Sheet for In-State Institutions
New Program or Substantial Modification to Existing Program

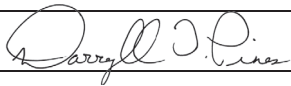| Institution Submitting Proposal	University of Maryland, College Park

*Each **action** below requires a separate proposal and cover sheet.*

○ New Academic Program   ○ Substantial Change to a Degree Program

○ New Area of Concentration   ○ Substantial Change to an Area of Concentration

○ New Degree Level Approval   ○ Substantial Change to a Certificate Program

◉ New Stand-Alone Certificate   ○ Cooperative Degree Program

○ Off Campus Program   ○ Offer Program at Regional Higher Education Center

Payment Submitted: ◉ Yes ○ No   Payment Type: ◉ R*STARS # ○ Check #   Payment Amount: $850   Date Submitted: 10/19/202⊞

Department Proposing Program	Geographical Sciences
Degree Level and Degree Type	Post-Baccalaureate Certificate
Title of Proposed Program	Remote Sensing
Total Number of Credits	12
Suggested Codes	HEGIS: 220603.00 · CIP: 45.0702
Program Modality	◉ On-campus · ○ Distance Education (*fully online*)
Program Resources	◉ Using Existing Resources · ○ Requiring New Resources
Projected Implementation Date	◉ Fall ○ Spring ○ Summer · Year: 2022
Provide Link to Most Recent Academic Catalog	URL: https://academiccatalog.umd.edu/

Preferred Contact for this Proposal	Name:	Michael Colson
	Title:	Senior Coordinator for Academic Progams
	Phone:	(301) 405-5626
	Email:	mcolson@umd.edu

President/Chief Executive	Type Name:	Darryll J. Pines
	Signature:	Date: 09/23/2021
	Date of Approval/Endorsement by Governing Board:	

Revised 1/2021

A. Centrality to the University's Mission and Planning Priorities

Description. The University of Maryland (UMD) proposes a **Post-Baccalaureate Certificate in Remote Sensing**, which will provide advanced training in collecting, processing, analyzing, and visualizing geospatial data through remote-sensing platforms, such as satellite images, aerial photos, and drone images. Students will take courses that cover all major aspects of remote sensing, including digital image processing and analysis, working with Lidar, drones for data collection, and computer programming that is critical for data processing and analysis. Students will understand how remote sensing is applied to real-world problems, and graduates will have the necessary knowledge and skills to work as a remote sensing professionals and specialists.

Relation to Strategic Goals. This program, which is derived from core and elective requirements in UMD's already established Master of Science in Geospatial Information Sciences (GIS) program, aligns with the University of Maryland's stated goal for graduate education to "Expand professional graduate programs that are nationally recognized for excellence in their curricula, their contributions to the practice of the professions, and for their innovation and creativity."[1] Training in Remote Sensing will be beneficial for Maryland citizens living in the Washington, DC, metropolitan area, as there are more GIS and Remote Sensing related activities and needs in this region than anywhere else in the country because of the high concentration of federal agencies, NGOs, and private organizations engaging in geospatial sciences.

Funding. The program will be funded from tuition and fee revenue. The Department of Geographical Sciences, which will offer the program, already offers the courses that are required for the program through its Master of Science in GIS program. Accordingly, the facilities, infrastructure, and instructional resources are already in place.

Institutional Commitment. The program will be administered by the Geographical Sciences department, which has the administrative and instructional resources to offer the program for five years. In the event that the certificate program is discontinued, the courses will continue to be offered for a reasonable time period so that enrolled students can finish the program. The faculty and administrative infrastructure will still be in place to work with students who have not finished the program.

B. Critical and Compelling Regional or Statewide Need as Identified in the State Plan

Need. UMD is in a unique geographical location because it is in the Washington metropolitan area, within highly populated Prince Georges county and in reasonable driving distance from Montgomery County, Frederick County, Howard County, and southern Maryland. The Washington Metropolitan Area Transit Authority's public transportation system also serves both Montgomery County and Prince George's County with both bus and metrorail service. There are more GIS and remote sensing related activities and needs in this region than anywhere else in the country because of the high concentration of federal agencies, NGOs, and private organizations engaged in geospatial activities. For example, NASA, with operations located in Prince George's County and Washington DC, and NOAA, with offices in Silver Spring, are two of the most important users of remote sensing data from various sources such as satellite images and aerial photos. UMD is

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[1] University of Maryland, College Park. (August 1, 2018). University of Maryland Mission Statement. (p. 5). Retrieved May 20, 20212 from: https://svp.umd.edu/sites/default/files/2019-09/Mission-Vision.pdf.

particularly well positioned to play a strong role in geospatial research and education. Our Department of Geographical Sciences is well known for research in remote sensing and recognized as a leader worldwide.

State Plan. The proposed program aligns with the Maryland State Plan for Postsecondary Education's emphasis on success and innovation by connecting students with the innovative technologies needed to be remote sensing specialists. Students have access to two 25-seat GIS labs with specialized software and hardware that allows students to engage in GIS training. The department's labs run a wide variety of commercial and open source software for GIS, remote sensing, statistical analysis, data access, image processing, mathematical analyses, graphics and 3D modeling, and software development. The program also has access to multiple high-performance computing resources.

C. Quantifiable and Reliable Evidence and Documentation of Market Supply and Demand in the Region and State

The need for a well-trained and nimble workforce in geospatial information sciences is growing, markedly. The US Bureau of Labor Statistics Occupational Outlook Handbook does not list geospatial information scientist as an occupation, but does project that jobs in a related category, cartographers and photogrammetrists, will be increasing. Nationally, jobs in this area are growing "as fast as average" at 4% between 2019-2029.[2] Within the state of Maryland, however, the Maryland Department of Labor lists the job growth rate at 14.42%,[3] reflecting that Maryland is one of the strongest states in the nation for jobs in the geographical sciences, mainly because of the prevalence of federal agencies.

UMD's existing Master of Science in GIS program recruits about 50 students in total annually. We have high confidence that the enrollment of the proposed Graduate Certificate program will be about 5 students or more per year. This projection is based on inquiries from prospective students and also on feedback from past students.

D. Reasonableness of Program Duplication

Other universities in the state of Maryland offer graduate certificate programs that are related to Geographic Information systems. Bowie State University offers a Post-Baccalaureate Certificate in Geographical Information Systems and Image Processing through its Department of Computer Science. Hood College offers a Post-Baccalaureate Certificate in Geographic Information Systems, as does Johns Hopkins University. The difference between UMD's proposed program and these existing programs is a matter of program focus. The focus of UMD's certificate is remote sensing, which is the study of objects (mainly earth surface objects such as water bodies and vegetation), without being in contact with those objects, by using imagery captured with help of electromagnetic radiation. The existing certificate programs are more broadly focused on geographic information systems. A geographic information system is a computer-based tool for

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[2] US Bureau of Labor Statistics. (April 9, 2021). Occupational Outlook Handbook: Cartographers and Photogrammetrists. Retrieved from: https://www.bls.gov/ooh/architecture-and-engineering/cartographers-and-photogrammetrists.htm

[3] Maryland Department of Labor, Licensing & Regulation. Maryland Occupational Projections – 2018-2028 – Workforce Information and Performance. Retrieved August 13, 2021 from http://www.dllr.state.md.us/lmi/iandoproj/maryland.shtml.

mapping and analyzing features and events on earth. GIS technology integrates common database operations, such as query and statistical analysis, with maps. A GIS program may or may not include components of remote sensing. UMD's certificate program emphasizes remote sensing. Each of the program's core requirements is focused on remote sensing.

E . Relevance to Historically Black Institutions (HBIs)

As mentioned above, Bowie State University offers a Post-Baccalaureate Certificate in Geographical Information Systems and Image Processing through its Department of Computer Science.

F.   Relevance to the identity of Historically Black Institutions (HBIs)

UMD's Department of Geographical Sciences currently offers a Master of Science in Geospatial Information Sciences. The courses required for the proposed certificate program consist of both required courses and elective courses that are currently offered through the master's program. The Department of Geographical Sciences' current faculty expertise, course offerings and research facilities allow it to offer a certificate program focused on remote sensing.

There should be no adverse impact on the identity of Bowie State University. Its Department of Computer Science offers its Post-Baccalaureate Certificate in conjunction with its Master of Science in Computer Science. The Bowie State certificate is one among other certificate options that allows students interested in computer science to focus on a particular applied area of computer science.

G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes
Curricular Development. UMD's Department of Geographical Sciences has been offering advanced education and training in geospatial technology since 2008. The students in this certificate program will take courses that cover all major aspects of remote sensing including digital image processing and analysis; working with Lidar, and drones for data collection, and be able to choose from a set of elective courses in programming, analytics, and data modeling, all of which are taught within the context of geospatial information science.

Faculty Oversight. Faculty and instructors who teach these courses will be drawn from the Department of Geographical Sciences. Administration and day-to-day management will be provided through the department's Center for Geospatial Information Science (CGIS), with the department faculty providing oversight from the Program Oversight Committee.

Educational Objectives and Learning Outcomes. The learning outcomes for this program are as follows:
1. Understand the big picture of remote sensing as a disciplinary field, including its history, current state, and future developments.
2. Grasp the connections between different geospatial technology components such as GIS, remote sensing, computing, and emerging software and hardware options, (for example, drones and artificial intelligence).
3. Understand how remote sensing is applied to real-world problems.
4. Develop proficiency in the following specific knowledge and skills:
    a. Collecting spatial data through various remote sensing platforms

b. Processing remote sensing data using software such as ENVI
c. Interpreting and analyzing remote sensing data
d. Automating the data processing and analysis through computer programming and scripting with languages such as Python
e. Understanding the analysis of big data with high performance computing, especially spatial data in large volume and high velocity

Institutional assessment and documentation of learning outcomes. Student learning outcomes assessment in graduate programs is directed by the Graduate Outcomes Assessment Committee. Established in 2011, this committee is comprised of representatives from each college and school. See Appendix A for more information about program assessment.

Course requirements. The total number of credits required for the certificate program is twelve. The program consists of three core courses for nine credits, and one elective course for three credits:

Core Courses:
1. GEOG652 Digital Image Processing and Analysis (3 credits)
2. GEOG660 Advanced Remote Sensing Using Lidar (3 credits)
3. GEOG666 Drones for Data Collection (3 credits)

Elective Courses (choose one):
- GEOG646 Programming for GIS (3 credits)
- GEOG653 Spatial Analysis (3 credits)
- GEOG654 GIS and Spatial Modeling (3 credits)
- GEOG656 Advanced Programming for GIS (3 credits)
- GEOG663 Big Data Analytics (3 credits)

See Appendix B for course descriptions.

General Education. Not applicable as this is a graduate program.

Accreditation or Certification Requirements. There are no specialized accreditation or certification requirements for this program.

Other Institutions or Organizations. The department will not contract with another institution or non-collegiate organization for this program.

Student Support. The advising infrastructure for this program already exists by virtue of the Geographical Sciences department's current graduate program operations. Program staff will provide students with an understanding of the UMD learning management system, academic support services, financial aid resources, and cost and payment policies from their existing programs. Otherwise, the Graduate Catalog will provide information about curricular requirements. Individual course syllabi will specify any technical competency or equipment requirements. Department staff will also advise prospective and enrolled students of the program requirements.

Marketing and Admissions Information. Marketing and admissions information will be available in the Graduate Catalog and available through the program advising office and website.

H. Adequacy of Articulation

As a graduate program, articulation is not applicable.

I. Adequacy of Faculty Resources

Program faculty. The program will rely upon current faculty in the Geographical Sciences department, which already offers the courses for this program through its Master of Science in Geospatial Information Sciences program. The faculty will be comprised of a combination of full-time, tenure-track and clinical faculty, adjunct professors, and graduate assistants. At least 50 percent of the total semester credit hours within the proposed program will be taught by full-time faculty.

See faculty biographies in Appendix C for the program's core faculty.

Faculty training. The Teaching and Learning Transformation Center at the University of Maryland inspires and supports effective, engaging, efficient, and equitable teaching innovations among the university's instructors and assistants. This team provides faculty with training, resources, professional development activities, and individualized consultation to transform their classrooms and careers.

For the learning management system, faculty teaching in this program will have access to teacher development opportunities available across campus, including those offered as part of the Teaching and Learning Transformation Center. For online elements of the coursework, instructors will work with the learning design specialists on campus to incorporate best practices when teaching in the online environment.

J. Adequacy of Library Resources

The University Libraries staff have reviewed the proposal and determined that the Libraries are able to meet, with its current resources, the curricular and research needs of the program.

K. Adequacy of Physical Facilities, Infrastructure, and Instructional Resources

The physical facilities and infrastructure needs for this program are minimal as faculty and students will use classrooms and office space that are already used by the department.
All students will have access to UMD's electronic mailing system. UMD maintains an Enterprise Learning Management System (ELMS) for elements of the coursework that will be online. ELMS is a Web-based platform for sharing course content, tracking assignments and grades, and enabling virtual collaboration and interaction.

L. Adequacy of Financial Resources

Resources for the program will be derived from tuition. See Tables 1 and 2 for anticipated resources and expenditures. Below is an itemized description.

Resources: Tuition revenue will be used to support the program. Graduate tuition rates are based on approved resident and non-resident rates, on a per-credit basis.

Expenditures:

1. Faculty: .25 FTE faculty will be allocated to the program. Tuition revenue generated from the program will be used to pay all instructional expenses.
2. Administrative Staff: The department already manages graduate programs and will be able to implement and maintain the program.
3. Support Staff: The current support staff for the department's graduate programs will be able to implement and maintain the program. 0.1 FTE of administrative support has been estimated for the program.
4. Equipment: Because of the department's current operation of its graduate programs, equipment costs for this program are minimal.
5. Library: As indicated in section J, current library resources are able to support the program.
6. New and/or Renovated Space: As indicated in section K, no new space is required. Current space used by existing faculty and staff members who will be operating the program will be sufficient.
7. Other expenses: $12,700 is budgeted for administrative costs ($3,500) and campus administrative costs ($7,200). An additional $2,000 will be set aside for marketing.

M. Adequacy of Program Evaluation

Formal program review is carried out according to the University of Maryland's policy for Periodic Review of Academic Units, which includes a review of the academic programs offered by, and the research and administration of, the academic unit (http://www.president.umd.edu/policies/2014-i-600a.html). Program Review is also monitored following the guidelines of the campus-wide cycle of Learning Outcomes Assessment (https://irpa.umd.edu/Assessment/loa_overview.html). Faculty within the department are reviewed according to the University's Policy on Periodic Evaluation of Faculty Performance (http://www.president.umd.edu/policies/2014-ii-120a.html). Since 2005, the University has used an online course evaluation instrument that standardizes course evaluations across campus. The course evaluation has standard, university-wide questions and also allows for supplemental, specialized questions from the academic unit offering the course.

N. Consistency with Minority Student Achievement goals

UMD has stated goals for recruiting and graduating a diverse population of graduate students in its strategic plan for diversity. The program will take the follow actions to recruit a diverse student population:

1. Advertise and promote the program through a variety of platforms including Google Ads, LinkedIn, etc.
2. Participate in and present at various conferences to reach a wider audience.
3. Work with alumni to help recruit underrepresented groups for the program.

O. Relationship to Low Productivity Programs Identified by the Commission

N/A

P. Adequacy of Distance Education Programs

N/A

Appendix A. Program Assessment

Assessment Plan

Student Learning Outcomes	Assessment Measures and Criteria	Assessment Schedule
1. Demonstrate continued retention of students and progress towards the graduate certificate completion.	**Measure**: Registrar's Enrollment Records **Criteria:** The majority (>80%) of existing students will be enrolled for courses each academic year.	2022 and then on a yearly basis
2. Students will demonstrate comprehension of knowledge and skills related to remote sensing	**Measure:** Successful completion of required courses **Criteria:** The majority (> 80%) of students will achieve a cumulative GPA of 3.0 or above	2022 and then on a yearly basis
3. Demonstrate completion of the certificate program.	**Measure**: Registrar's Graduation Records **Criteria**: The majority of students (>80%) will graduate within the five-year limit for graduate students.	2025 and then on a yearly basis
4. Students will assess the relevance of program content as it applies to their professional and educational needs. (The survey is web-based and students can submit their responses anonymously to encourage participation. The survey seeks to assess a student's experiences in the MSGIS Program regarding the quality of courses, the general program, faculty, and staff. The survey also collects information on employment at graduation.)	**Measure:** An exit interview will be conducted with graduates to assess their overall satisfaction with the program. **Criteria:** The majority (80%) of students will correlate academic program offerings to their needs.	2025 and then on a yearly basis

Appendix B. Course Descriptions

Core Courses (9 credits required):

GEOG652 Digital Image Processing and Analysis (3 Credits)
Digital image processing and analysis applied to satellite and aircraft land remote sensing data. Consideration is given to preprocessing steps including calibration and geo registration. Analysis methods include digital image exploration, feature extraction thematic classification, change detection, and biophysical characterization. One or more application examples may be reviewed.

GEOG660 Advanced Remote Sensing Using Lidar (3 Credits)
Lidar, also known as laser scanning, is an active remote sensing tool that can produce high-resolution point clouds. Lidar is being applied to problems such as terrain modeling, biomass estimation, change detection, feature extraction, and measuring tree canopy. Topics covered are fundamentals of lidar, current developments in lidar technology, and different applications where lidar is being used. Students will get hands-on learning about lidar data management, processing, and analysis.

GEOG666 Drones for Data Collection (3 Credits)
Topics covered in this class include: how to prepare students to obtain their FAA Remote Pilot License, understand how to pick drone systems for a data need, and utilize Pix4D to process drone imagery. Before talking about data students will learn about drone and aviation specific laws that will affect them while carrying out operations. Once legal limitations of drone flights have been covered the course will shift toward learning how to select a drone system based on specifications of the equipment and needs of the project and flying. Students will then move on to data processing utilizing Pix4D, Python, and Bash to clean data and automate processing.

Elective Choices (3 credits required):

GEOG646 Programming for GIS (3 Credits)
An introduction to computer programming using Python and web programming languages. It is required for students in the MSGIS program before they enroll in more advanced programming courses (GEOG656 and GEOG657). This course teaches students the fundamentals concepts of computer science. Students will learn about the components of a computer program such as data management, conditional statements, iterative statements, and file processing. Students will develop programs and web apps for the purpose of automating tasks and assisting with data analysis.

GEOG653 Spatial Analysis (3 Credits)
Methods of spatial analysis including measuring aspects of geometric features and identifying spatial patterns of geospatial objects that are represented as point, line, network, areal data, and 3-D surfaces.

GEOG654 GIS and Spatial Modeling (3 Credits)
Provide foundations and understanding on various issues related to modeling and simulation in GIS context. It will addresses the concepts, tools, and techniques of GIS modeling, and presents modeling concepts and theory as well as provides opportunities for hands-on model design, construction, and application. The focus will be on raster-based modeling. This course is also application-orientated, particularly in these fields such as terrain modeling, LULC modeling, hydrological modeling, suitability modeling, etc.

GEOG656 Advanced Programming for GIS (3 Credits)
Programming and scripting for intermediate GIS users. The fundamental concepts of computer programming will be introduced within the Geoprocessing framework in ArcGIS primarily using Python. Concepts of object-oriented programming and scripting will be presented. Students will develop skills in programming techniques to explore, manipulate and model spatial data using the Geoprocessor methods.

GEOG663 Big Data Analytics (3 Credits)
Designed to introduce statistical analysis over big data sets (and tackling big data problems), primarily in geography and spatial sciences, but with broader appeal throughout the socio-behavioral sciences. Students will be introduced to a range of methods that can be applied to the exploration, modeling, and visualization of big quantitative data. This course explores data fusion, statistical analysis, and data-mining for geospatial and non-geospatial data in structured and unstructured form, with an emphasis on large silos of data across diverse sources and assumptions. Topics will include open sourcing, metadata schemes, data standards and models, data-access, data-mining, clustering methods, classifiers, data reduction, machine learning, filtering schemes, real-time and streaming data, archiving and preservation, and handling uncertainty.

Appendix C. Core Department of Geographical Sciences Faculty who will Teach in the Program

Name	Title & Status	Credentials	Courses
Jianguo Ma	Principal Lecturer, Full-Time	Ph.D., Biological and Environmental Engineering, Cornell University	GEOG653, GEOG656, GEOG660
Jonathan Resop	Senior Lecturer, Full-Time	Ph.D., Biological Systems Engineering, Virginia Tech	GEOG646, GEOG654, GEOG656
Rejanne Le Bivic	Lecturer, Full-Time	Ph.D., Geosciences, University of Western Brittany	GEOG646, GEOG652, GEOG654, GEOG660
Naijun Zhou	Lecturer, Full-Time	Ph.D., Geospatial Information Science, University of Wisconsin, Madison	GEOG652

Table One: Resources

Resource Categories	2021-2022	2022-2013	2023-2024	2024-2025	2025-2026
1. Reallocated Funds	$0	$0	$0	$0	$0
2. Tuition/Fee Revenue					
a. #F.T Students					
b. Annual Tuition/Fee Rate					
c. Annual Full-time Revenue (a x b)					
d. # Part-time Students	5	5	5	5	5
e. Credit Hour Rate (current differential rate subject to change)	$800	$816	$832	$849	$866
f. Annual Credit Hours	12	12	12	12	12
g. Total Part Time Revenue (d x e x f)	$48,000	$48,960	$49,920	$50,940	$51,960
3. Grants, Contracts, and Other Resources					
4. Other Sources					
TOTAL (add 1- 4)	$48,000	$48,960	$49,920	$50,940	$51,960

Table Two: Expenditures

Expenditure Categories	2021-2022	2022-2013	2023-2024	2024-2025	2025-2026
1. Total Faculty Expenses (b + c below)	$24,250	$24,948	$25,665	$26,404	$27,164
a. #FTE	.25	.25	.25	.25	.25
b. Total Salary	$21,250	$21,888	$22,544	$23,220	$23,917
c. Total Benefits	$3,000	$3,060	$3,121	$3,184	$3,247
2. Total Administrative Staff Expenses (b + c below)	$0	$0	$0	$0	$0
a. #FTE	0	0	0	0	0
b. Total Salary	$0	$0	$0	$0	$0
c. Total Benefits	$0	$0	$0	$0	$0
3. Total Support Staff expenses	$2,280	$2,326	$2,372	$2,420	$2,468
a. # FTE	.1	.1	.1	.1	.1
b. Total Salary	$2,000	$2,326	$2,372	$2,420	$2,468
c. Total Benefits	$280	$286	$291	$297	$303
4. Equipment	$1,500	$1,545	$1,591	$1,639	$1,688
5. Library	$0	$0	$0	$0	$0
6. New or Renovated Space	$0	$0	$0	$0	$0
7. Other Expenses	$9,200	$9,384	$9,572	$9,763	$9,958
a. Marketing	$2,000	$2,040	$2,081	$2,122	$2,165
b. Administrative Fee	$7,200	$7,344	$7,491	$7,641	$7,794
TOTAL (add 1-7)	$37,230	$38,202	$39,200	$40,226	$41,279